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1920 Old Middlefield Way
Mountain View, CA 94043

650.967.2365 PHONE
650.967.2785 FAX

www.trcsolutions.com

July 9, 2015
175498

Mr. Ted Ibarra
SANTA CLARA VALLEY WATER DISTRICT
5750 Almaden Expressway
San Jose, California 95118

RE: SUPPLEMENTAL GEOTECHNICAL RECOMMENDATIONS
LOWER BERRYESSA CREEK FLOOD PROTECTION PROJECT – PHASE 1
MILPITAS, CALIFORNIA

Dear Mr. Ibarra:

In this letter we provide supplemental geotechnical recommendations for the flood- and retaining-walls for the above referenced project. As you know, we prepared a report titled “Design Level Addendum, Berryessa Creek Geotechnical Investigation Report, Lower Berryessa Creek Project, Santa Clara Valley Water District, Milpitas, California,” dated November 9, 2010. We provided additional geotechnical recommendations for the design of cast-in-drilled-hole piers in 2014. We understand that the project is proposed to include the construction of flood walls and retaining walls which will be founded on cast-in-drilled-hole (CIDH) piers. We understand that you need soil input parameters for axial and lateral design of the CIDH piers. Based on our recent discussions with Santa Clara Valley Water District (SCVWD) staff, we revised our generalized soil profile and provide these revised recommendations that will supersede our recommendations provided in 2014.

AXIAL CAPACITY OF CIDH PIERS

We are providing geotechnical recommendations for axial capacity for the proposed piers based on previously obtained subsurface data and liquefaction calculations. Based on our discussions with you, non-liquefiable soils above the bottom of the deepest liquefiable layer were considered to provide axial capacity for the proposed piers. The CIDH piers will develop their vertical capacity from frictional support in the stiff foundation clays and dense sand below the deepest liquefiable soil strata. Due to the depth of liquefiable soils and subsurface exploration that was limited to 40 to 50 feet below the existing ground surface, the pier skin friction was extrapolated based on a constant undrained shear strength of the foundation clays below the maximum exploration depth. The inputs of the analysis are summarized below in Table 3 below.

We computed allowable downward vertical capacities for 24-inch diameter CIDH piers. A summary of the allowable pier capacities for CIDH piers are presented in Table 1. In addition, Figure 1 shows the increase in pier capacity with depth. Dead loads should not exceed two-thirds of the computed capacities. Uplift loads should also not exceed two-thirds of the computed downward capacities on Figure 1. For the static case, we used a factor-of-safety of 1.5 for the allowable vertical capacities. For the seismic case, we used a factor-of-safety of 1.3 for the allowable vertical capacities of the soils above and below the approximately 10 foot thick liquefiable layer shown on Figure 1.

Table 1. Estimated Allowable Capacities for 24-inch CIDH Piers

Length* (feet)	Estimated Allowable Capacity (dead plus live loads) (kips)	Estimated Allowable Capacity (dead plus live plus transient loads) (kips)
24	81	48
25	87	54
26	92	60
27	97	66

* Pier length as measured from bottom of grade beam

We have assumed a base of grade beam at an approximate elevation of 10 feet. To effectively minimize pier group effects and reduction in individual pier capacity, piers should be located with a minimum center-to-center spacing of three times the pier diameter.

LATERAL CAPACITY OF CIDH PIERS

Table 3 presents the geotechnical input parameters used for the lateral capacity analyses. The horizontal modulus of subgrade reaction was estimated based on references by Bowles (1997) and Isenhower and Wang (2010). Values in parentheses are recommended value used in modelling liquefied sand and include residual strengths interpreted from Idriss and Boulanger (2008).

To estimate lateral capacities of piers, we used a computer program that models the soil response in the form of load-deflection (p-y) curves to estimate the capacity of the piers to resist the expected lateral loads. The lateral load characteristics for 24-inch diameter, 25 foot long CIDH pier with fixed- and free-head conditions are presented in Table 2 below. A 25 kip axial load was used.

Table 2. Estimated Lateral Pier Response –24-inch CIDH Piers

Condition	Head Condition	Deflection (inches)	Maximum Shear Force (kips)	Maximum Moment (ft-kips)	Depth to Maximum Moment (ft)
Static	Free	¼	22	96.0	7.75
		½	31	149.3	8.5
	Fixed	¼	45	238.3	Top of Pier
		½	66	396.8	
Seismic	Free	¼	22	94.5	7.75
		½	30	144.5	8.5
	Fixed	¼	41	216.6	Top of Pier
		½	53	314.6	

Figure 2 shows shear force as a function of pier head deflection. Shear versus depth and moment versus depth plots for free and fixed head conditions for both static and seismic cases are attached. Pier head deflection versus pier length plots for free and fixed head conditions for both static and seismic cases are attached.

The analysis results represent the probable response of the piers under short-term loading conditions and include no factor-of-safety. Suitable factors-of-safety should be selected on the basis of the type of loading. A pier stiffness (EI) of 5.9×10^{10} lb-in^2 was assumed in our calculations of load deflection for the 24-inch piers. We assumed a minimum compressive strength of 4,000 pounds per square inch for concrete modulus calculations.

Table 3. CIDH Pier Design Recommendations

Begin Station	End Station	Elevation Range (ft)	Axial Capacity		Lateral Capacity					
			Ult. Skin Friction Value Static (psf/ft)	Ult. Skin Friction Value Seismic (psf/ft)	Soil Model	Total Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)	ε_{50}	K (pci)
1+35	25+60	10 to 5	450	450	Stiff Clay w/o Free Water	120	800	-	0.008	300
		8.5	Design groundwater elevation							
		5 to -1	650	650	Stiff Clay w/o Free Water	120	1,200	-	0.007	400
		-1 to -11	885	0	Sand (static) Soft Clay (seismic)	120	250 (sesmic)	30 (static)	0.020 (seismic)	30 (static) 200 (sesimic)
		-11 to -22	1,225	1,225	Sand	125	-	34	-	30
		-22 to -30	825	825	Stiff Clay w/o Free Water	125	1,500	-	0.006	450
		Below -30*	825	825	Stiff Clay w/o Free Water	125	1,500	-	0.006	450

Notes:
psf – pounds per square foot
pcf – pounds per cubic foot
pci – pounds per cubic inch
* – below depth of exploration. Soil properties and skin friction extrapolated

CLOSURE

This letter was prepared for the Santa Clara Valley Water District for Phase 1 of the Lower Berryessa Creek Flood Protection Project in Milpitas, California in accordance with generally accepted geotechnical engineering practices at this time and location. No warranty is expressed or implied.

We hope this provides you with the information you need at this time. If you have any questions, please call and we will be glad to discuss them with you.

Sincerely,

Scott M. Leck

Scott M. Leck, P.E., G.E.
Principal Geotechnical Engineer

SCOTT M. LECK
No GE002067
Exp. 6/30/2016

Attachments: Shear vs Depth Plot, Static, Free Head
Moment vs Depth Plot, Static, Free Head
Shear vs Depth Plot, Static, Fixed Head
Moment vs Depth Plot, Static, Fixed Head
Shear vs Depth Plot, Seismic, Free Head
Moment vs Depth Plot, Seismic, Free Head
Shear vs Depth Plot, Seismic, Fixed Head
Moment vs Depth Plot, Seismic, Fixed Head
Deflection vs Length Plot, Static
Deflection vs Length Plot, Seismic

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Figure 1

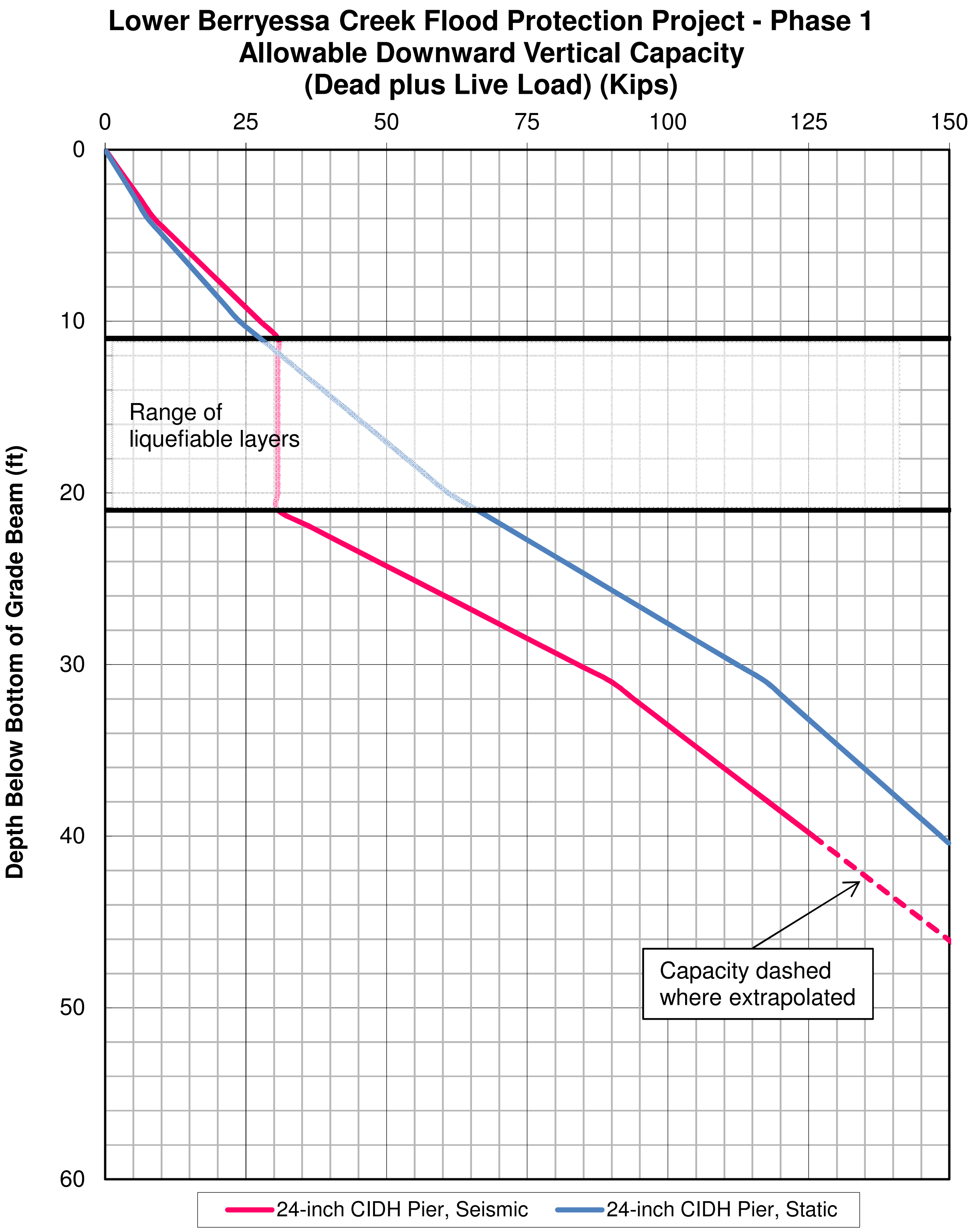
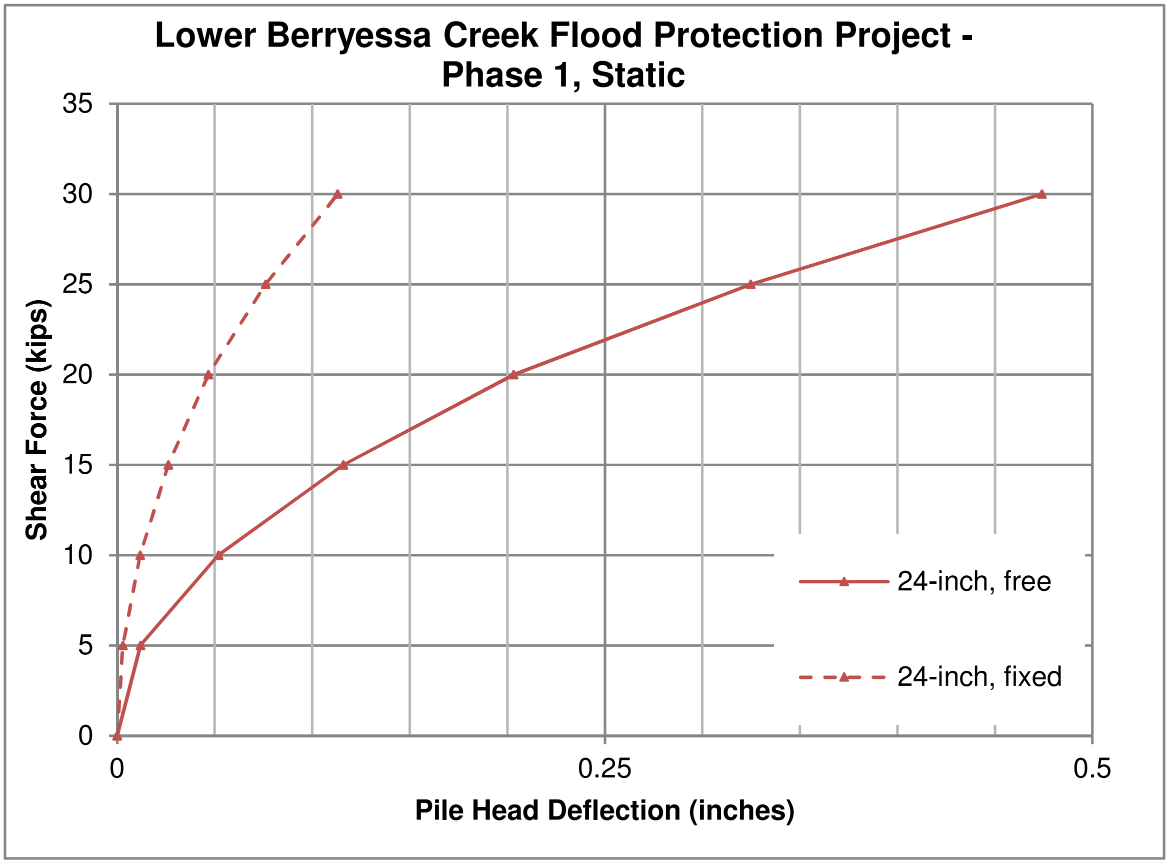
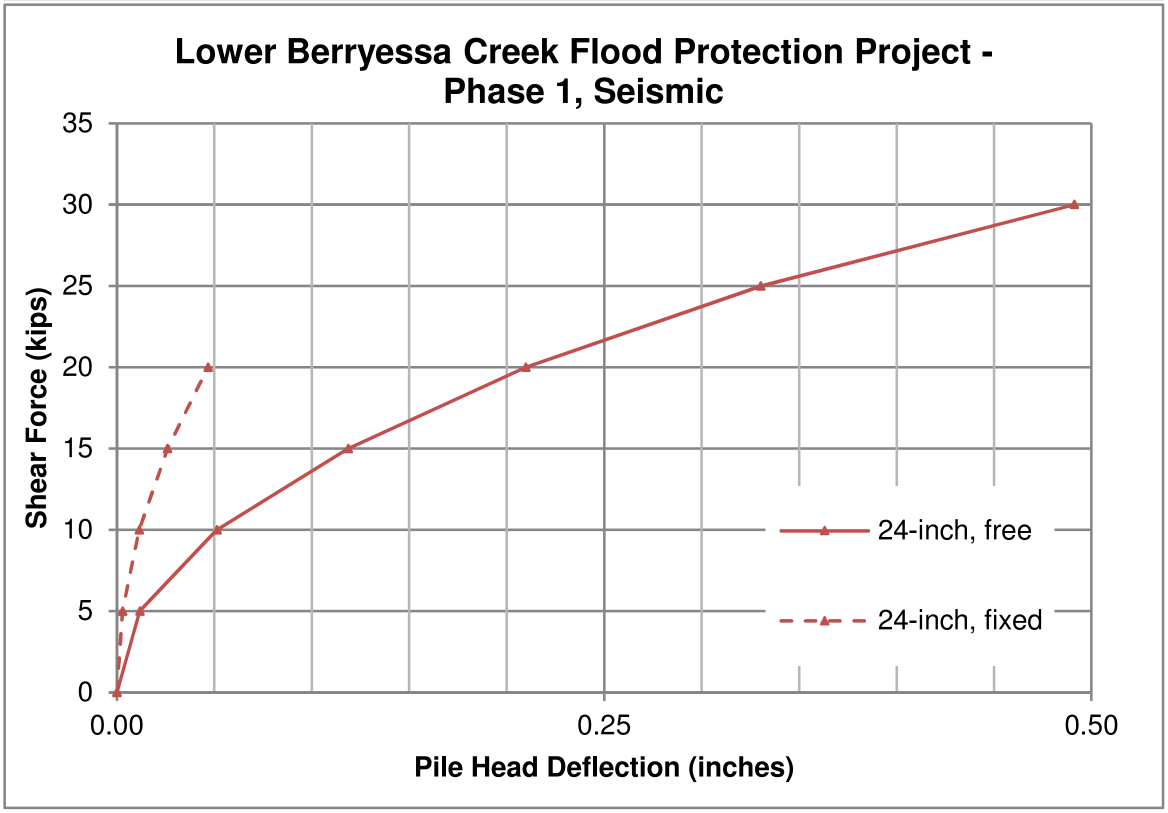
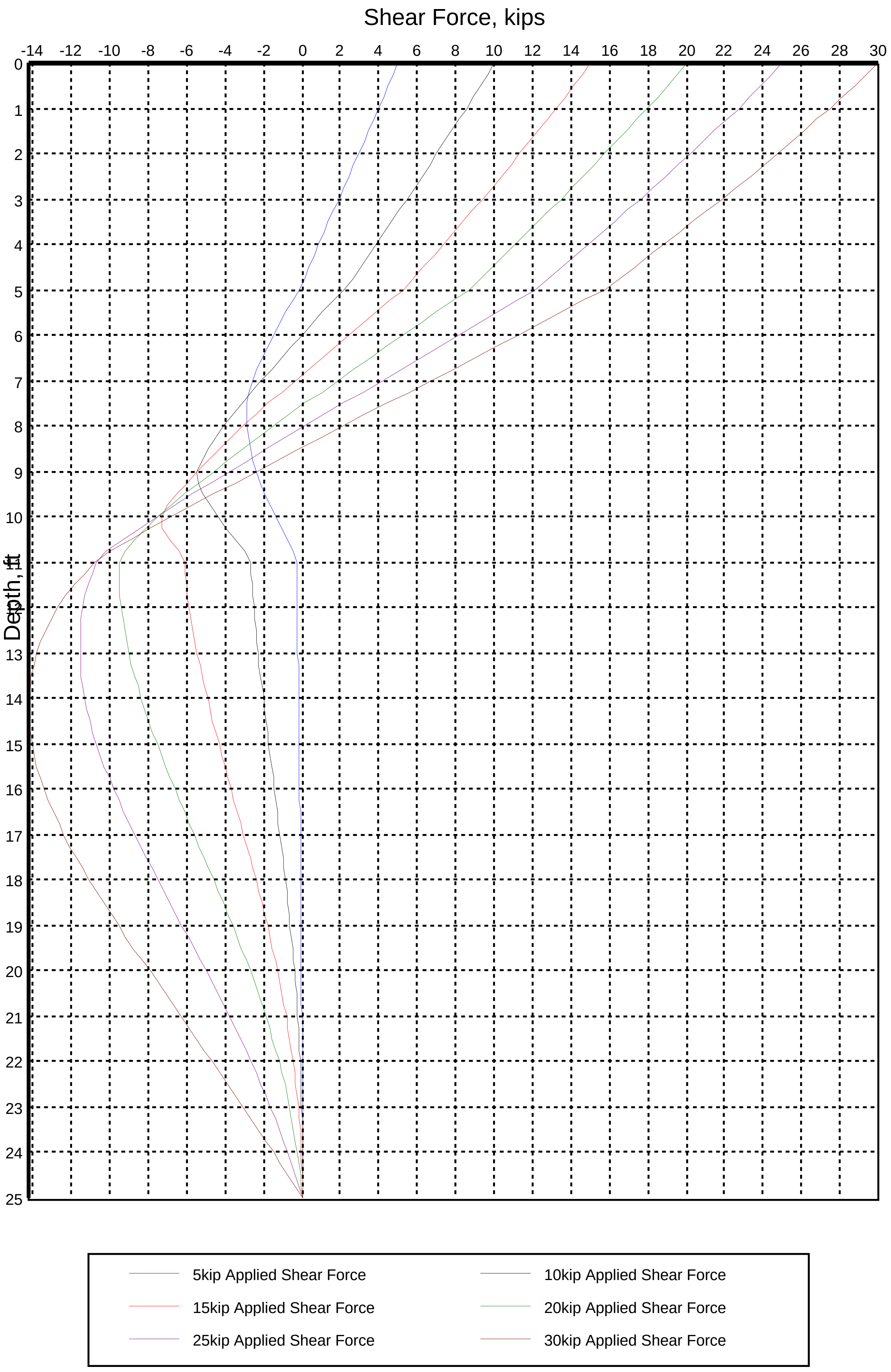

Lower Berryessa Creek Flood Protection Project - Phase 1
Allowable Downward Vertical Capacity
(Dead plus Live Load) (Kips)
0
25
50
75
100
125
150
0
10
20
30
40
50
60
Depth Below Bottom of Grade Beam (ft)
Range of
liquefiable layers
Capacity dashed
where extrapolated
24-inch CIDH Pier, Seismic
24-inch CIDH Pier, Static

Figure 2


Lower Berryessa Creek Flood Protection Project -
Phase 1, Static
Shear Force (kips)
35
30
25
20
15
10
5
0
0
0.25
0.5
Pile Head Deflection (inches)
24-inch, free
24-inch, fixed


Lower Berryessa Creek Flood Protection Project -
Phase 1, Seismic
Shear Force (kips)
35
30
25
20
15
10
5
0
0.00
0.25
0.50
Pile Head Deflection (inches)
24-inch, free
24-inch, fixed

Shear Force vs. Depth, Static, Free Head



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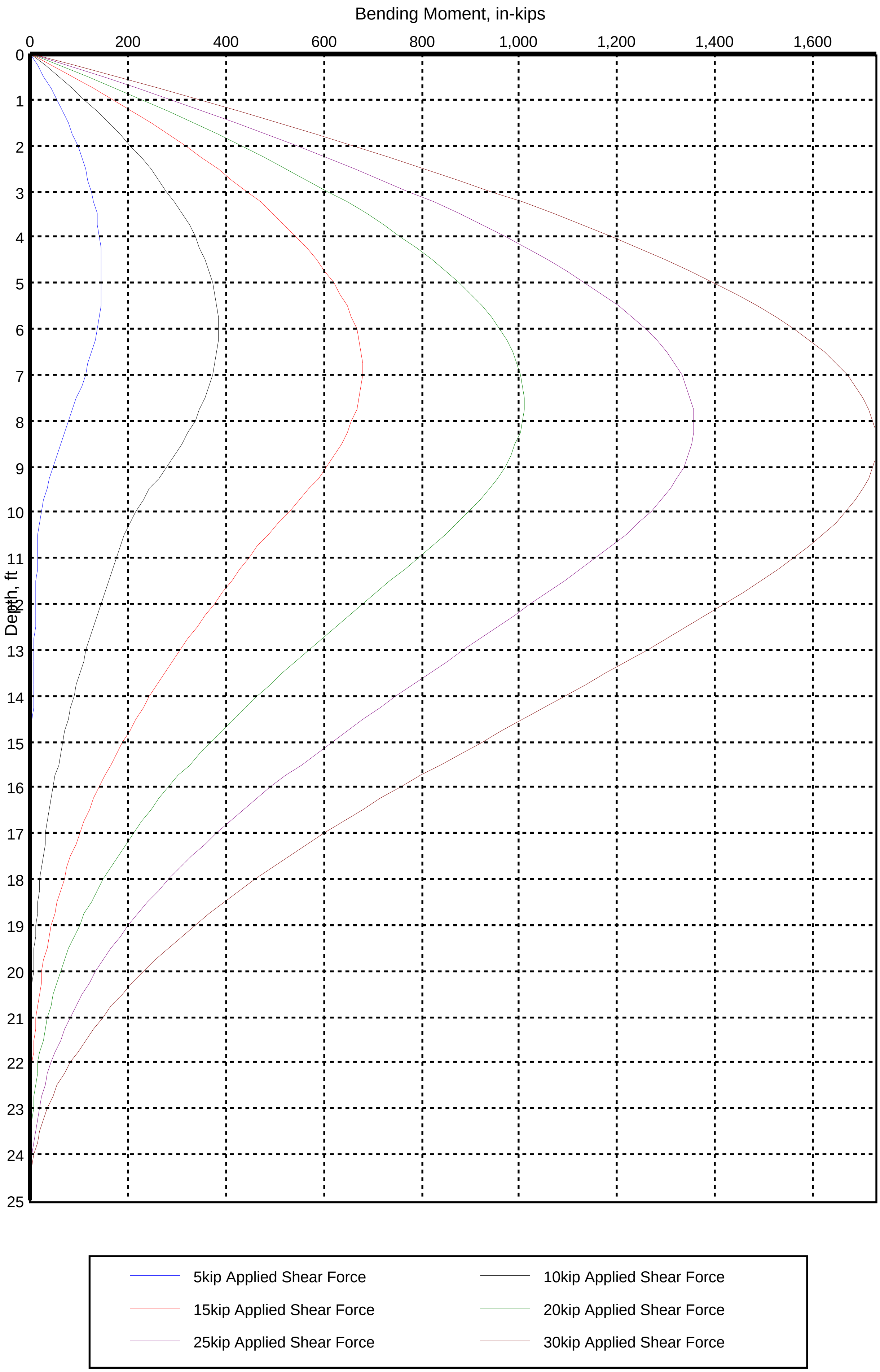
Bending Moment vs. Depth, Static, Free Head

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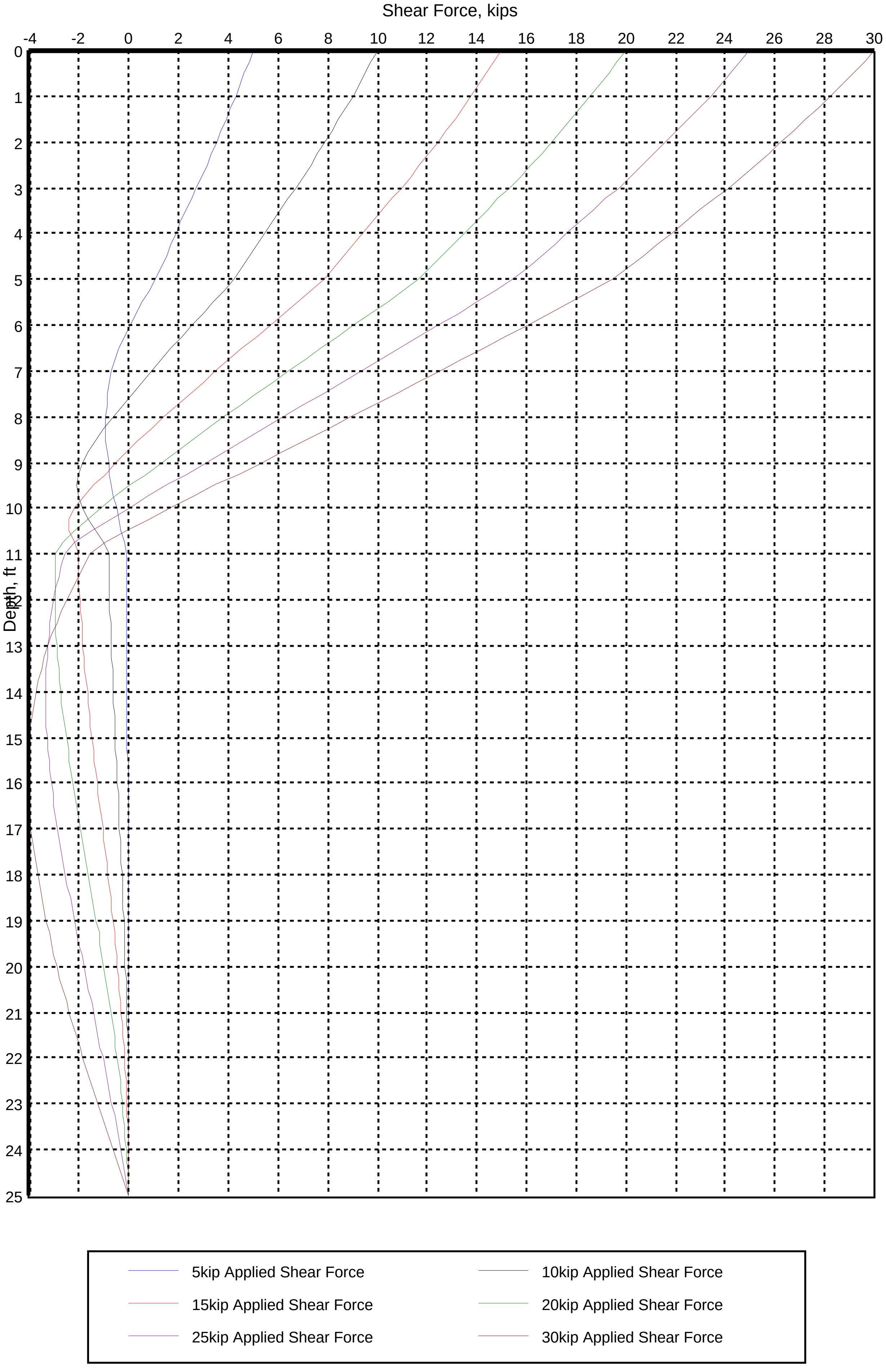
Shear Force vs. Depth, Static, Fixed Head



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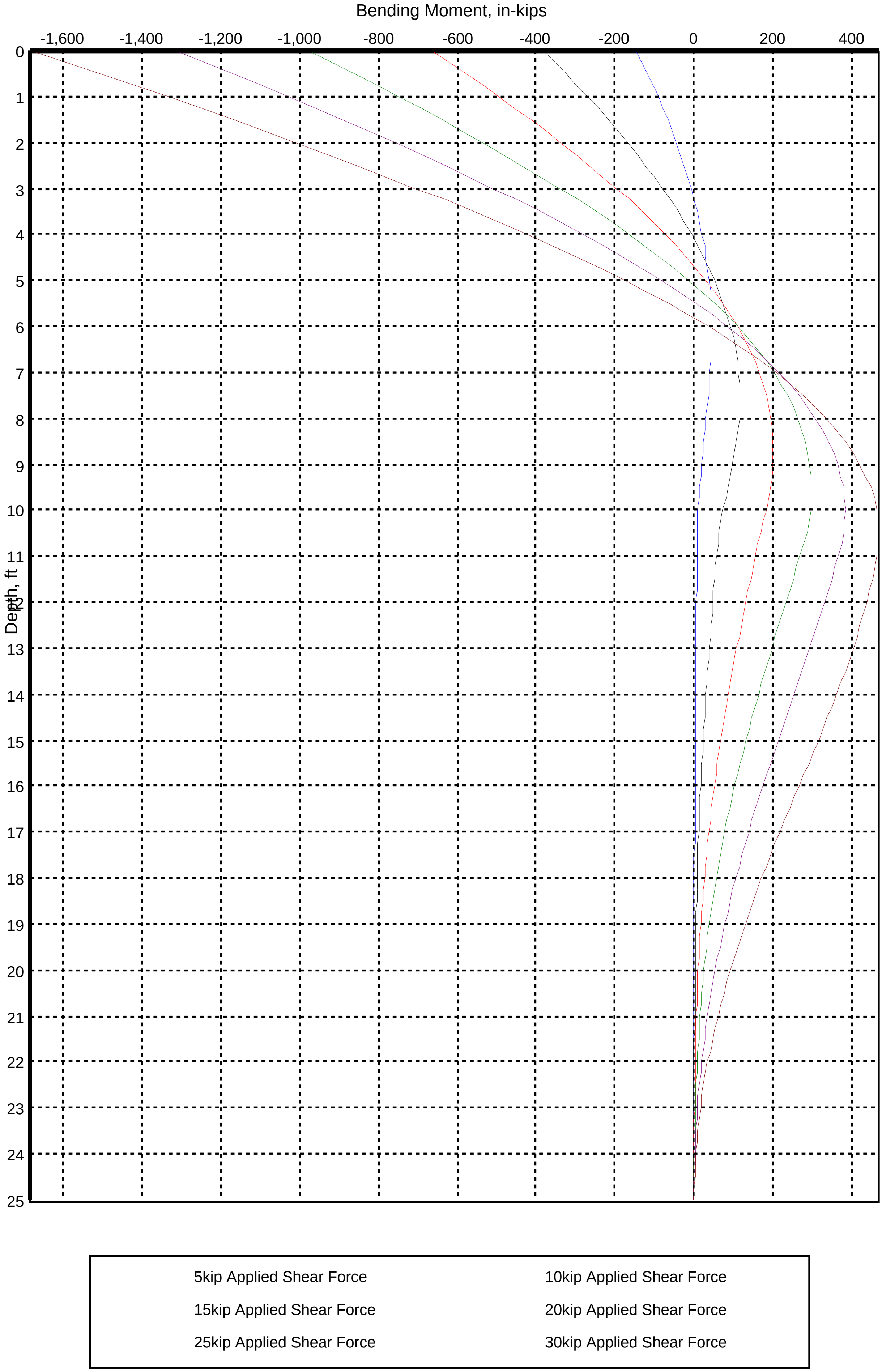
Bending Moment vs. Depth, Static, Fixed Head



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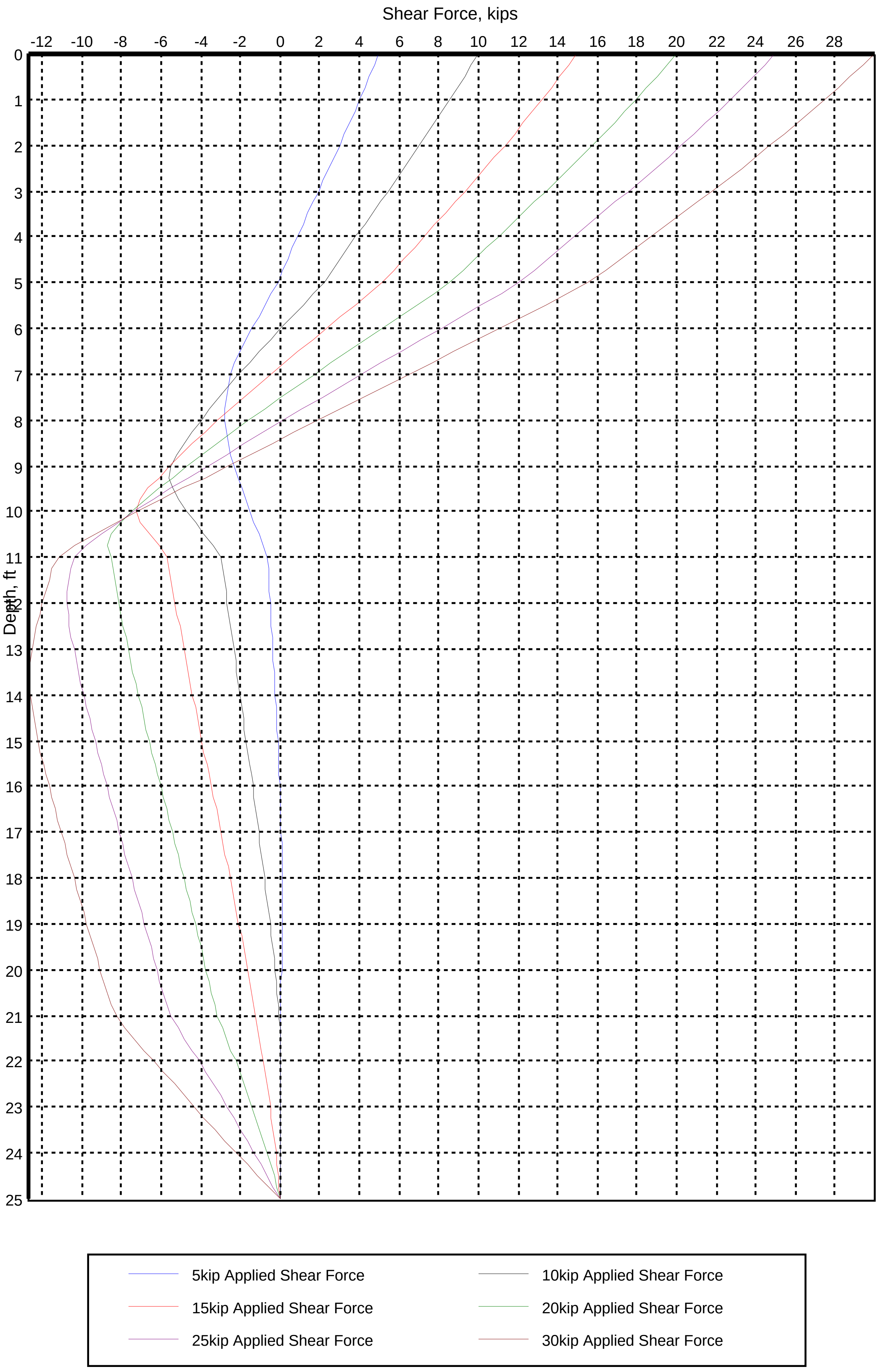
Shear Force vs. Depth, Seismic, Free Head



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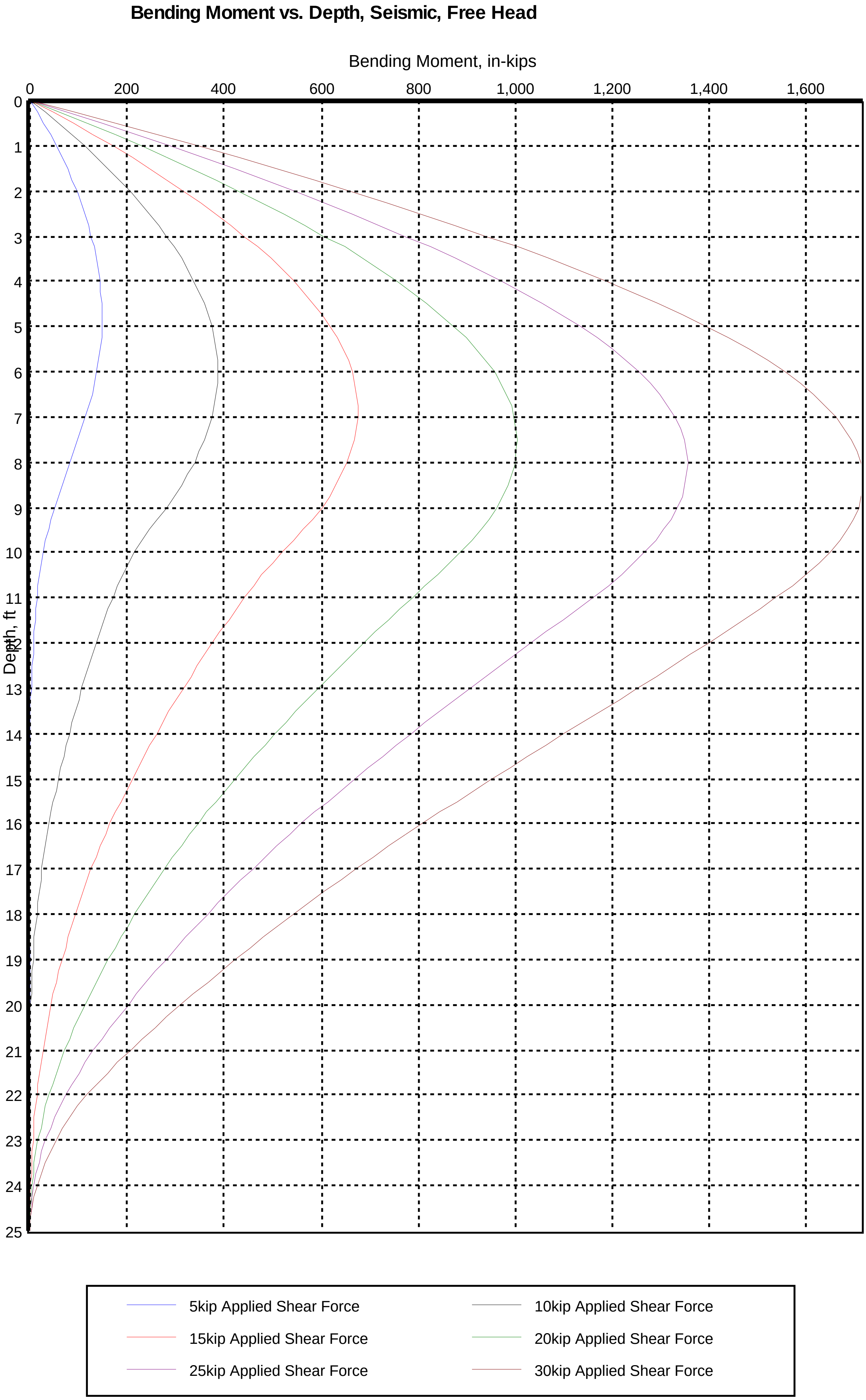

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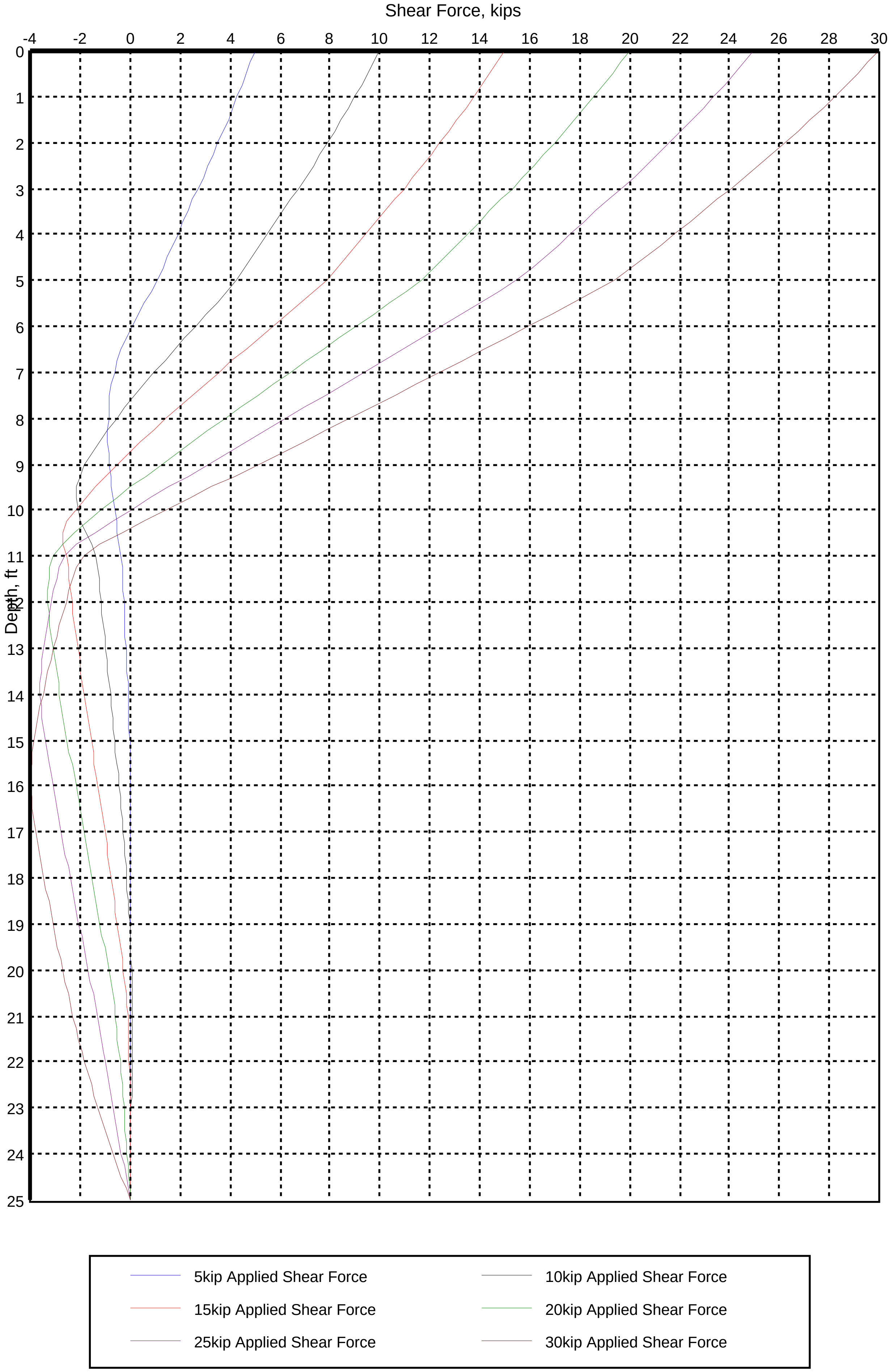
Shear Force vs. Depth, Seismic, Fixed Head



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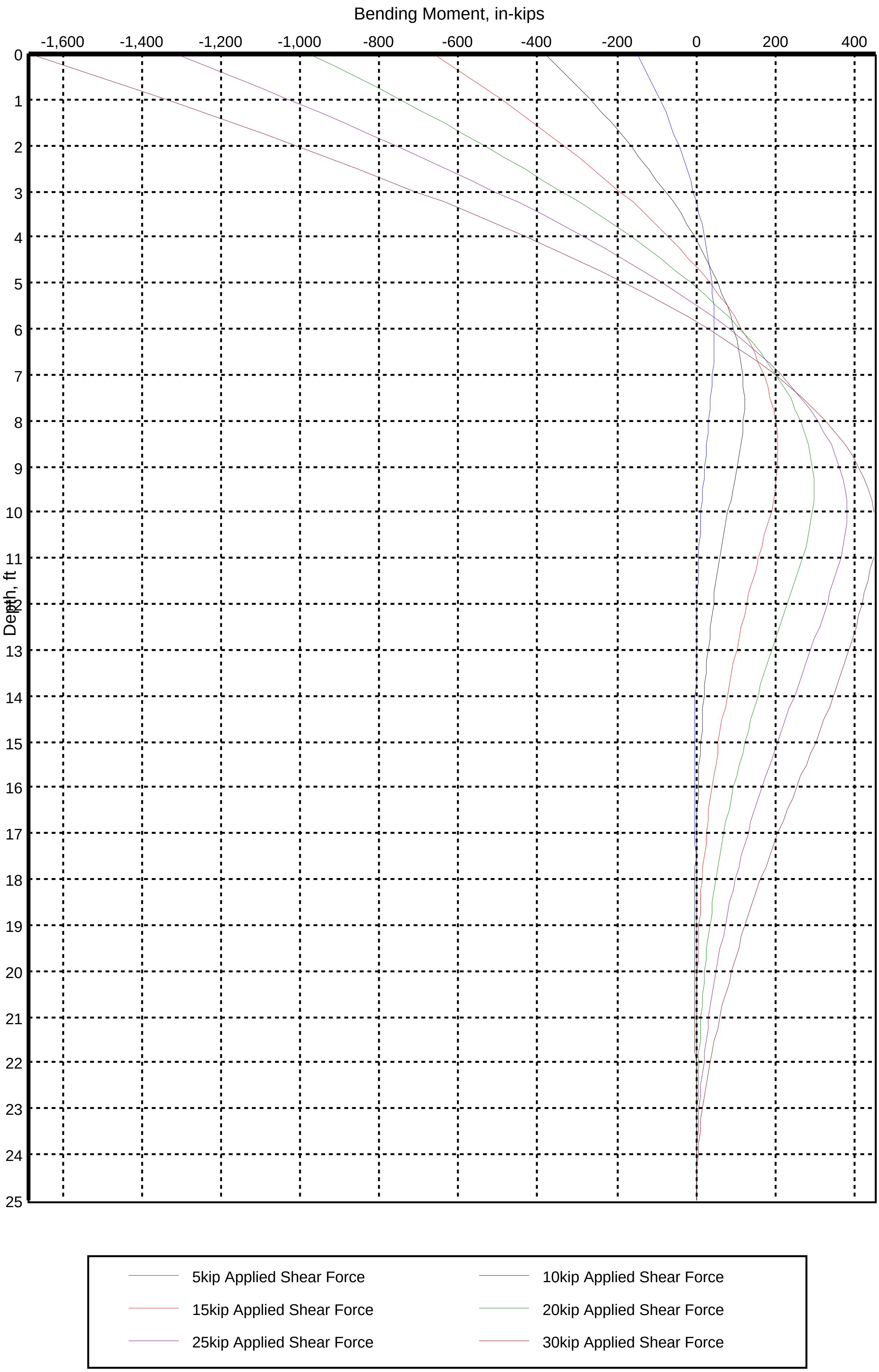
Bending Moment vs. Depth, Seismic, Fixed Head



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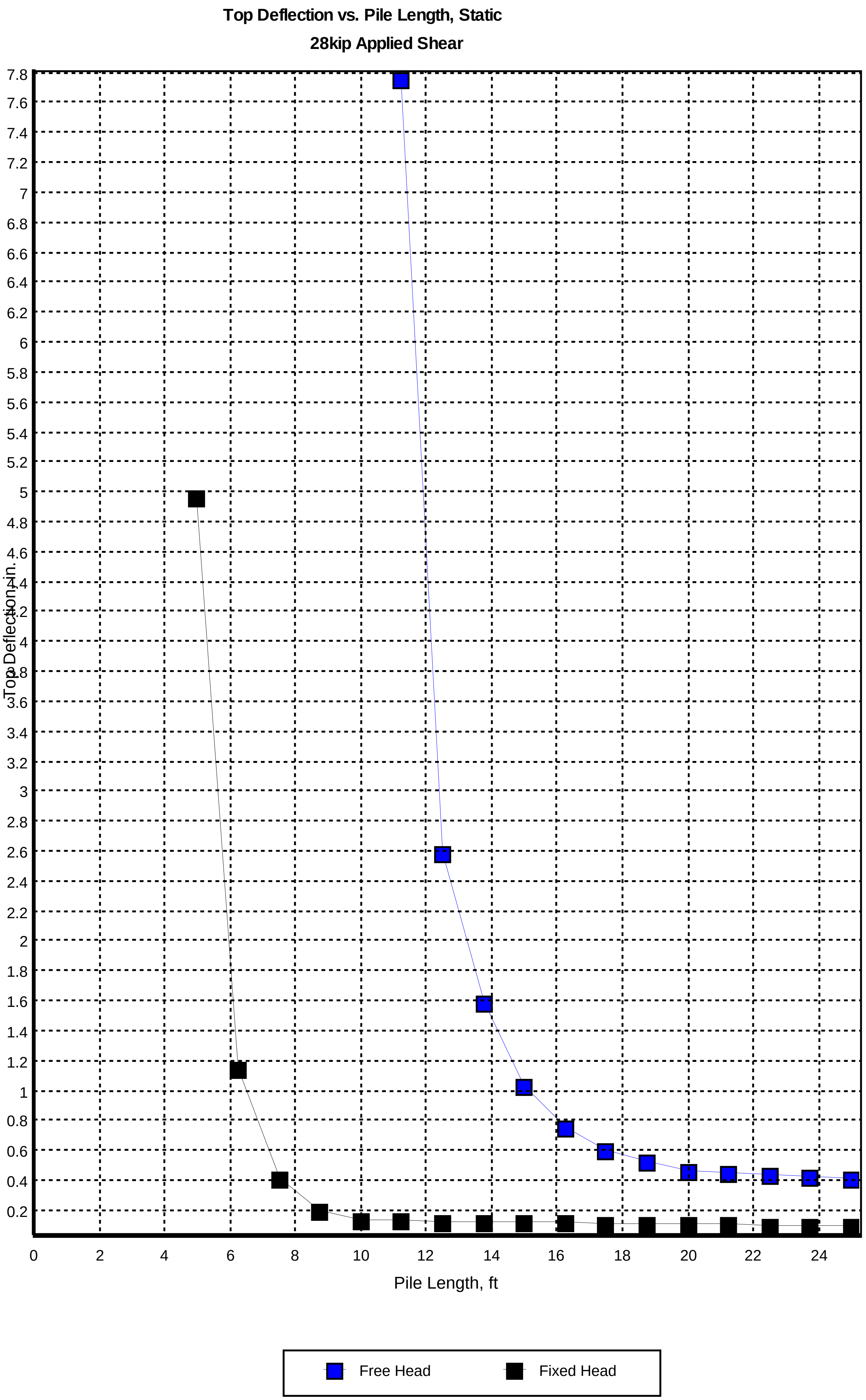

Top Deflection vs. Pile Length, Static

28kip Applied Shear

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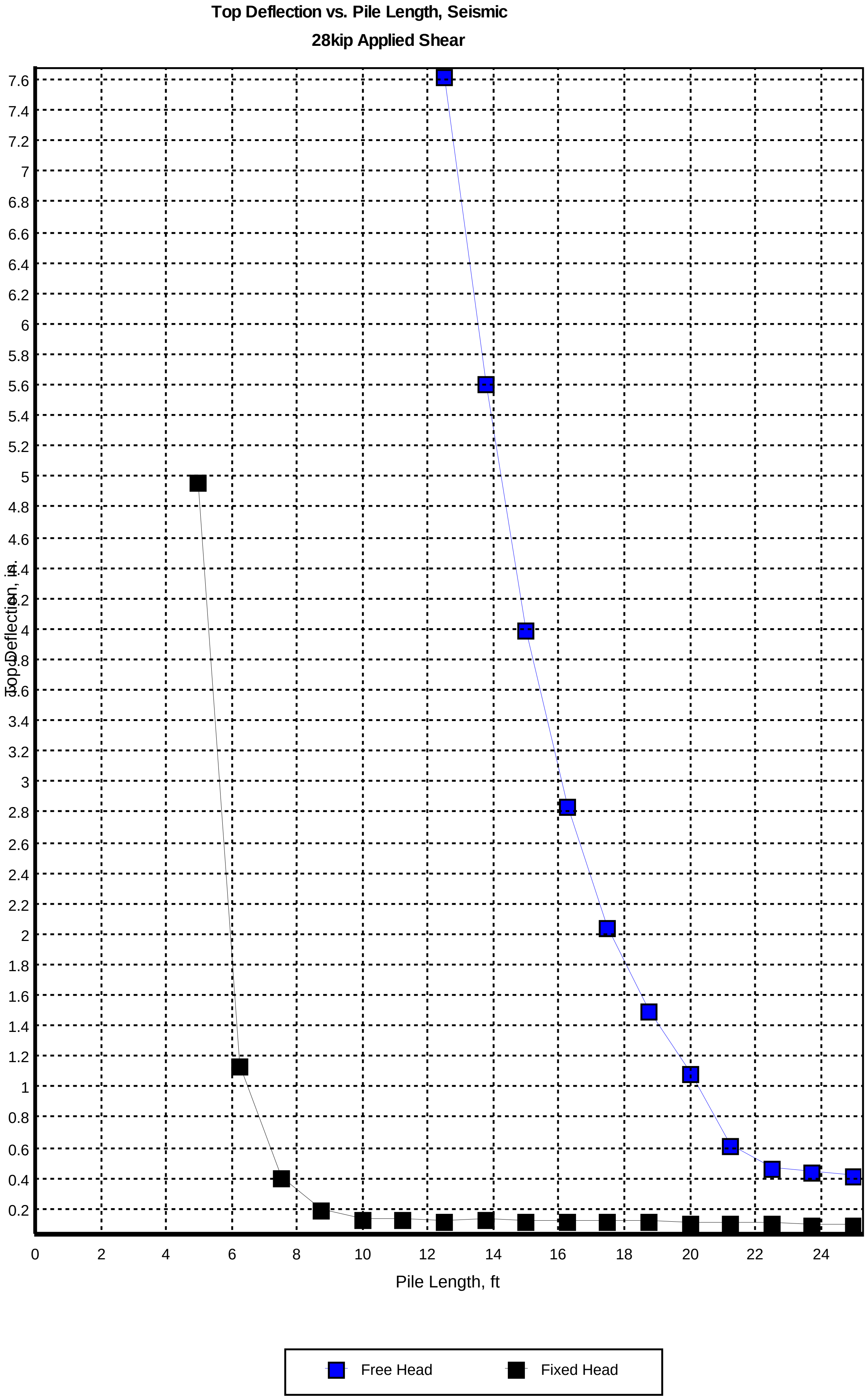

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